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Papers

Use of waist circumference to predict insulin resistance: retrospective study

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Insulin resistance is an important pathogenic factor in common metabolic disorders. No easy clinical test exists for predicting the insulin resistance of an individual. We assessed how effectively different anthropometric measurements and biochemical markers used in clinical practice can predict insulin sensitivity.

Participants, methods, and results

We analysed a sample of 2746 healthy volunteers (798 male) from retrospectively collected data. Ages ranged from 18 years to 72 years, body mass index (kg/m^2) from 18 to 60, and waist circumferences from 65 cm to 150 cm (see table A on bmj.com for further data). We determined height, weight, waist circumference (midway between the lateral lower ribs and the iliac crest), and hip circumference. Results from analyses of venous plasma for glucose, insulin, lipids, and leptin concentrations were used. We used homoeostasis model assessment (HOMA index) as a measure of insulin sensitivity (plasma glucose (mol/l) × plasma insulin (mU/l)/22.5)—an established test in epidemiological studies.[1] We defined insulin resistance as a HOMA score >3.99, on the basis of a definition for a white population.[2]

We used multivariate regression models to assess the predictive power of the variables (see bmj.com). We used receiver operating characteristics (ROC) curve analysis to select an appropriate cut-off for variables. In the multiple regression model, waist circumference was the strongest regressor of the five significant covariates (standardised partial regression coefficients: waist circumference $\beta_1 = 0.37$; log-plasma triglycerides $\beta_2 = 0.23$; systolic blood pressure $\beta_3 = 0.10$, high density lipoprotein cholesterol $\beta_4 = -0.09$; and body mass index $\beta_5 = 0.15$ ($P < 0.001$)). The areas under the ROC curves were 0.8915 (standard error 0.008) for men and 0.8644 (0.007) for women, respectively, indicating a very good discriminating power. On the basis of the ROC curves, we set the optimal cut-off for detecting insulin resistance at 100 cm for waist circumference in both sexes. The table shows the number of true and false positives and negatives in both sexes (see also the figure on bmj.com). Sensitivities and specificities were between 94-98% and 61-63% respectively in both sexes. The positive predictive values in our sample were 61% in men and 42% in women (these figures depend on the prevalence of insulin resistance in the actual sample). The negative predictive value was 98% in both sexes. With a cut-off of 88 cm in women (the level cited in guidelines) the specificity dropped to 49%.[3]

What is already known on this topic

Waist circumference is an independent risk factor for cardiovascular disease

The cut-off for high risk of cardiovascular disease is 102 cm and 88 cm in men and women respectively

What this study adds

Waist circumference is a very good predictor of insulin sensitivity; a waist circumference of < 100 cm excludes insulin resistance in both sexes

Ability to select insulin resistance and sensitivity among healthy men and women by using 100 cm waist circumference as cut-off. Insulin resistance was defined as a HOMA score >3.99. Waist circumference and HOMA score were available for 2648 participants

	Insulin resistance		Insulin sensitivity	
	Men	Women	Men	Women
Waist ≥100 cm	277	388	176	543
Waist <100 cm	7	25	293	939

Means (95% binomial confidence intervals) for sensitivities, specificities, and positive and negative predictive values were, for men and women respectively: sensitivities 0.98 (0.95 to 0.99) and 0.94 (0.91 to 0.96); specificities 0.63 (0.59 to 0.68) and 0.63 (0.61 to 0.66); positive predictive values 0.61 (0.56 to 0.66) and 0.42 (0.38 to 0.45); and negative predictive values 0.98 (0.95 to 0.99) and 0.97 (0.96 to 0.98).

Comment

A waist circumference of < 100 cm excludes individuals of both sexes from being at risk of being insulin resistant. Waist circumference is a strong independent risk factor for insulin resistance and the most powerful regressor in our model. It replaces body mass index, waist:hip ratio, and other measures of total body fat as a predictor of insulin resistance and explains more than 50% of the variation in insulin sensitivity alone.

Current guidelines suggest a cut-off of 102 cm in men and 88 cm in women, on the basis of the many metabolic risk factors after waist circumference is stratified in fifths.[3] However, with 88 cm as a cut-off in women the specificity drops markedly. In the San Antonio heart study, twice as many women as men had a waist circumference above the level given in the current guidelines, whereas the prevalence of the metabolic syndrome was similar in both sexes, thus supporting the notion that abdominal obesity is overestimated in women.[4] The coupling of insulin resistance with abdominal obesity suggests a biological link at the fat cell level. Hyperinsulinaemia activates 11β-hydroxysteroid dehydrogenase in omental adipose tissue, thus generating active cortisol and promoting a cushingoid fat distri-

P+ *Further data are on bmj.com*

bution.[5] Waist circumference is a simple tool to exclude insulin resistance and to identify those at greatest risk (therefore those who would benefit most from lifestyle adjustments).

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